PanGEO INCORPORATED
Geotechnical & Earthquake
Engineering Consultants

June 6, 2019
File No. 19-150

Troy Werelius
c/o H2D Architecture + Design
23020 Edmonds Way, #113 Edmonds,
Washington 98020
Attn: Ms. Heidi Helgeson

Subject: **Geotechnical Engineering Report**
Proposed Addition
8452 North Mercer Way, Mercer Island, WA

Dear Mr. Werelius:

As requested, PanGEO Inc. completed a geotechnical engineering evaluation to assist with the design and construction of the proposed building addition at above referenced property. Our study was performed in general accordance with the scope of work outlined in our proposal dated May 2, 2019, which was subsequently authorized by the homeowner on May 3, 2019. Our scope of services included:

1. Reviewing readily available geologic/geotechnical data in the site vicinity,
2. Drilling one test boring,
3. Conducting a site reconnaissance, and
4. Developing the conclusions and recommendations presented in this report.

SITE AND PROJECT DESCRIPTION

The subject site is located at 8452 North Mercer Way in Mercer Island, Washington (see Figure 1 – Vicinity Map). The property is generally bordered by Mercer Park Lane to the north and west and by private residences to the south and east. The site is currently occupied by a three-story single-family residence, as shown in Plate 1 (see Page 2). We understand the proposed addition will be located at the southeast corner of the existing building (see location in attached Figure 2).

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The proposed building addition location is currently occupied by a shed structure, as shown in Plate 2 (see Page 2).

Plate 1. View of north side of the house from Mercer Park Lane, looking south.

Plate 2. View of the proposed building addition location, looking west.

Based on review of the topographic survey, the existing grade of the site generally descends from the southwest to the northeast corner of the property with a total vertical relief of about 16 feet. Within the proposed building addition footprint, the existing grades are relatively level.

We understand the proposed project consists of replacing the existing shed structure with a building addition. The addition will consist of an elevated interior space supported on one post at the southwest corner, and the ground level will be finished with a concrete slab-on-grade for an outdoor shower area.

Because the property consists of a watercourse located to the west of the existing building, we understand that the City requires a geotechnical evaluation for the foundation support of the new addition.

SUBSURFACE EXPLORATION

Our subsurface exploration consisted of advancing one soil boring (PG-1) near the location of the proposed addition to a depth of about 36½ feet below the existing ground surface on May 13, 2019. The approximate boring location is shown on the attached Figure 2.

The boring was drilled using Bobcat-mounted mini track drill rig owned and operated by Geologic Drill Partners. The drill rig was equipped with a 6-inch outside diameter hollow stem auger. Standard penetration tests (SPT) were performed in the boring using a 2-inch outside diameter split-spoon sampler at 2½ and 5-foot intervals. SPT sampler was driven into the soil a distance of 18 inches below the auger tip using a 140-pound weight falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The blow count provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained (cohesive) soils.

A geologist from our firm was present throughout the field exploration program to observe the drilling, assist in sampling, and describe and document the soil samples obtained from the borings. The soil samples were described using the system outlined on Figure A-1, and the summary boring log is included as Figure A-2.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

According to the *Geologic Map of Mercer Island* (Troost and Wisher, 2006), the subject site is underlain by deposits sourced from pre-Olympia age nonglacial deposits ranging from very dense coarse grain deposits consisting of sand and gravel (Qponc) to hard, fine grain deposits of silt and clay (Qponf). The general area of the site is also identified as being underlain by mass-wastage deposits (Qmw). Mass-wastage deposits are described as loose to dense/soft to stiff, colluvium, soil, landslide debris, and organic matter with indistinct morphology.

Based on the results of our test boring PG-1, it is our opinion that the site subsurface conditions generally confirm the mapped geology, as detailed below.

The following is a brief description of the soils encountered in the test boring. Please refer to the summary boring log included in Appendix A for additional details.

> ***UNIT 1 – Fill:*** Loose, brown to dark brown, silty fine SAND with some gravel, organics and rootlets was encountered in our test boring to approximately 2 feet below existing ground surface. We interpret this unit as fill.
>
> ***UNIT 2 – Mass-Wastage Deposit (Qmw):*** Below the fill, our test boring encountered loose, brown to gray-brown, slightly laminated, silty fine SAND with occasional fine gravel. This unit contained an organic-rich layer at about 8½ feet deep. We interpret this layer as mass-wastage deposit. Unit 2 extended to approximately 10 feet below existing ground surface.

UNIT 3 – Pre-Olympia Coarse-grained Nonglacial Deposits (Qponc): Below the mass-wastage deposits, PG-1 encountered medium dense to dense, silty gravelly SAND and sandy GRAVEL extending to a depth of about 17½ feet below the surface, which we interpret as Pre-Olympia coarse-grained nonglacial deposits.

UNIT 4 – Pre-Olympia Fine-Grained Nonglacial Deposits (Qponf): Below Unit 3, our test boring encountered very stiff to hard silty CLAY extending to the maximum depth advanced at about 36½ feet below the surface. We interpret this unit as Pre-Olympia fine-grained nonglacial deposits.

Groundwater seepage was encountered at about 10 feet below the ground surface in the test boring. It should be noted that groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, and other factors. Groundwater levels and seepage rates are normally highest during the winter and early spring (typically October through May).

SEISMIC CONSIDERATIONS

Seismic Design Parameters – The following provides seismic design parameters for the site that are in conformance with the 2015 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. It is our opinion that Site Class D is appropriate for this project.

Soil Liquefaction – Liquefaction is a process that can occur when soils lose shear strength for short periods of time during a seismic event. Ground shaking of sufficient strength and duration results in the loss of grain-to-grain contact and an increase in pore water pressure, causing the soil to behave as a fluid. Soils with a potential for liquefaction are typically cohesionless, predominately silt and sand sized, must be loose to medium dense, and be below the groundwater table.

Our test boring encountered medium dense to dense, sand and gravel below the groundwater table, which are not considered prone to soil liquefaction. As such, it is our opinion that the liquefaction potential of the site is low and design considerations related to soil liquefaction are not necessary for this project.

FOUNDATION

Existing Building Foundation – The existing building was remodeled in 2000. The design plans for the previous remodeling project indicated the existing building is supported on conventional footings. Based on our field observations on May 13, 2019, it appeared that the existing building walls/foundation have performed adequately without clear evidence of settlement or cracks.

Proposed Building Addition Foundation – We anticipate the proposed building addition will be relatively lightweight. In our opinion, the proposed addition can be supported on conventional footings. Based on the results of our test boring PG-1, the soils at the design footing subgrade elevation likely consist of fill soils (silty fine sand with organics and roots). In our opinion, the fill soils should be completely removed and over-excavated to at least 3 feet below the base of the proposed footings. The footing over-excavation should be backfilled with properly compacted structural fill such as crushed surfacing base course outlined in Section 9-03.9(3) of the 2018 WSDOT Standard Specifications or approved equivalent to provide a firm and uniform support.

Deep foundation such as piles may not be used to support the addition. In our opinion, if used, the pile-supported building addition will likely be subject to potential differential settlement from the footing-supported existing building.

The following include our recommended foundation design parameters:

Allowable Bearing Pressure – We recommend that the proposed footing be sized using a maximum allowable bearing pressure of 1,200 psf. The recommended value may be increased by 1/3 for transient conditions such as wind and seismic loadings.

Footing Over-Excavation – The footing over-excavation should be at least 3 feet (from below the bottom of the footing) and should extend at least one foot horizontally beyond the edge of footings. Due to the presence of adjacent existing building foundation, the over-excavation should not extend below 1H:1V (horizontal:vertical) downward projection line from the nearby existing footings to avoid undermining the existing footings.

The adequacy of the exposed subgrade should be verified by PanGEO on the field. The bottom of the over-excavation should be re-compacted to a dense condition (if compactable).

Footing Size and Embedment – All footings should be founded a minimum depth of 18 inches below the adjacent finish grade. Spread and continuous footings should have minimum widths of 24 and 18 inches, respectively.

Lateral Resistance – Lateral forces from wind or seismic loading may be resisted by the 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 300 per cubic foot (pcf). The above values include a factor of safety of at least 1.5 assuming that properly compacted structural fill will be placed adjacent to the sides of the footings. A coefficient of friction of 0.35 may be used to determine the frictional resistance at the base of the footings bearing in structural fill and native sand. The recommended coefficients include a factor of safety of approximate 1.5.

Settlement Estimate – We estimated the total foundation settlement to be less than 1 inch and differential foundation settlement to be less than ½ inch. Most of the anticipated settlement should occur during construction as dead loads are applied.

Concrete Slab-On-Grade – We understand that proposed concrete slab on grade will be added as part of the building addition. Because the soils at the design slab subgrade elevation are anticipated to be loose, we recommend that at least 1 foot of loose fill be removed and replaced by properly compacted structural fill (i.e. crushed surfacing base course or approved equivalent).

WATERCOURSE

Based on the project survey, the watercourse at the site is over 50 feet away from the proposed building addition. Because the excavation for the proposed building addition will be relatively shallow (i.e. less than 4 feet deep) with a small footprint, we do not anticipate the excavation and backfill for the proposed building addition to impact the watercourse. We also do not anticipate that the proposed addition supported on footings placed on properly compacted structural fill to be impacted by the nearby watercourse. The above statements are valid provided our recommendations outlined in the report are incorporated into the design and construction of the project.

CONSTRUCTION CONSIDERATIONS

Temporary Unsupported Slope Cuts – We recommend that temporary excavation be sloped to maintain stability. Temporary unsupported slope cuts should be sloped at 1H:1V or flatter.

Erosion Considerations – We recommend that the exposed slopes be covered with plastic sheeting. 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 to collect runoff and prevent water from entering the excavation. Silt fences or straw wattles can be used along the perimeter in the downslope portion of the site to prevent construction runoff from exiting the site.

CLOSURE

We have prepared this report for use by Mr. Troy Werelius and your project team. Recommendations contained in this report are based on a site reconnaissance, shallow subsurface explorations, a 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 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.

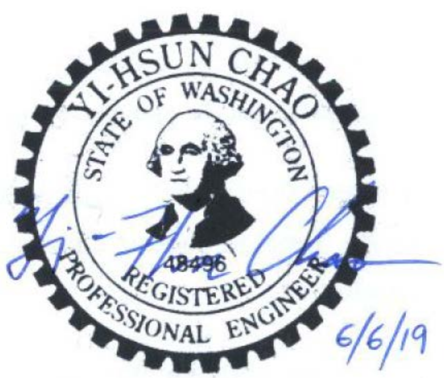
This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

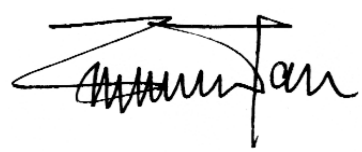
This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. 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,





Yi-Hsun William Chao
Senior Project Geotechnical Engineer

Siew L. Tan, P.E.
Principal Geotechnical Engineer

Attachments:

Figure 1 – Vicinity Map
Figure 2 – Site and Exploration Plan

Appendix A – Summary Hand Boring Logs

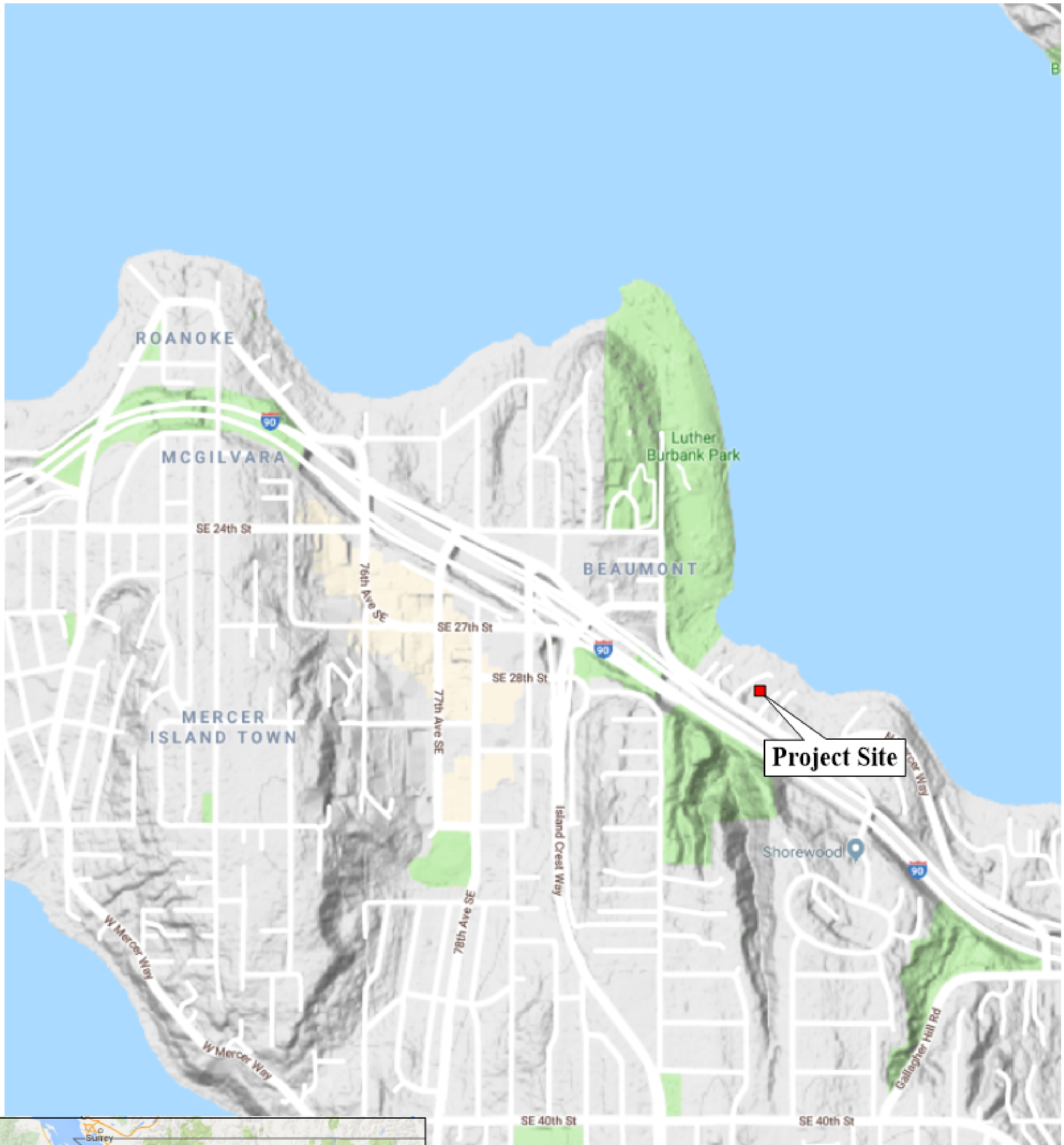
Figure A-1 – Terms and Symbols for Boring and Test Pit Logs
Figure A-2 – Log of Test Boring PG-1

REFERENCES

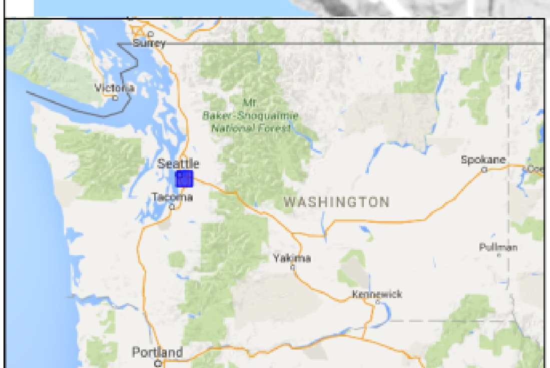
International Building Code (IBC), 2015, International Code Council.

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

Washington State Department of Transportation (WSDOT), 2018, *Standard Specifications for Road, Bridges, and Municipal Construction*, Olympia, Washington.



Base Map: Google Terrain



NORTH

Not to Scale

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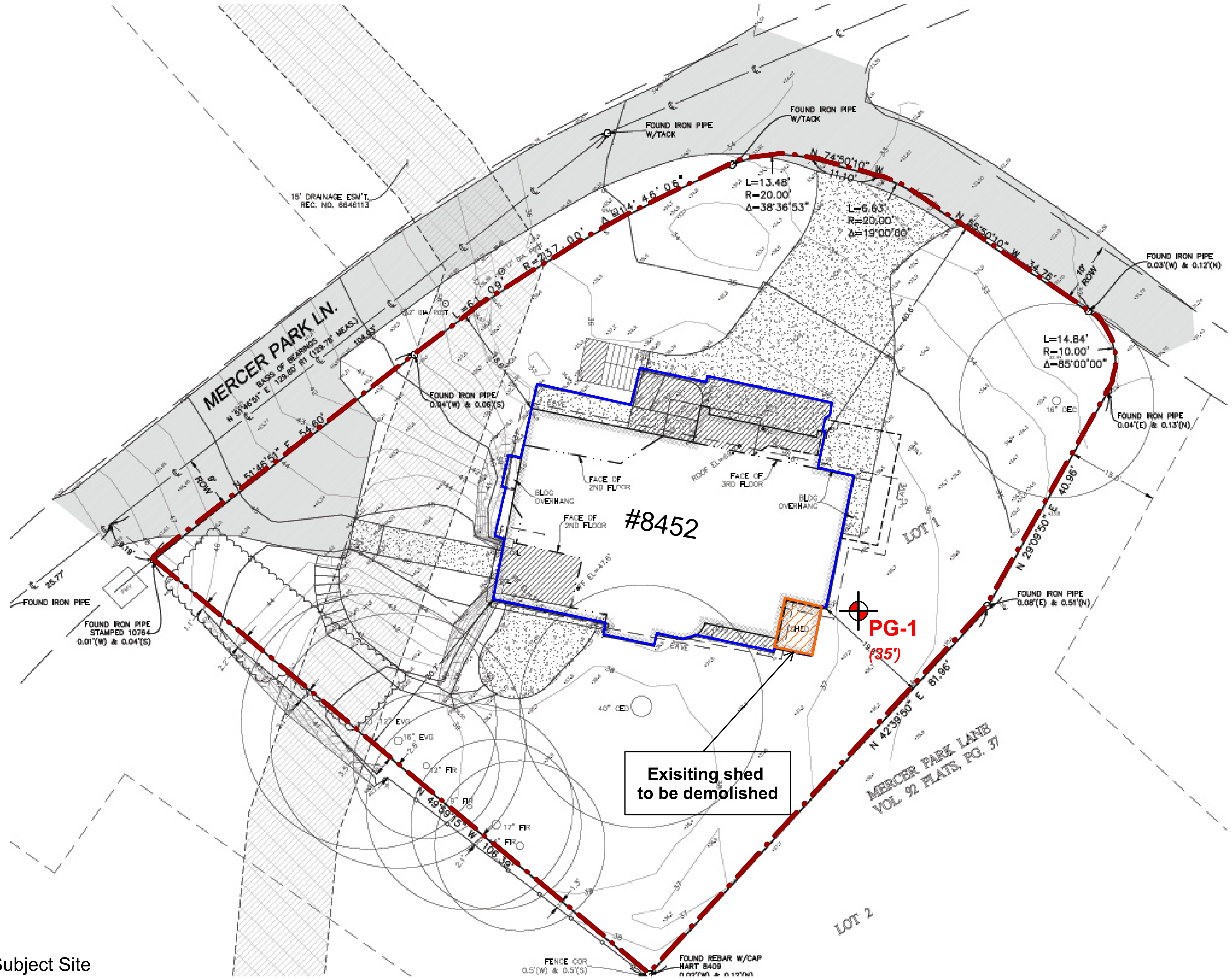
Proposed Addition
8452 North Mercer Way
Mercer Island, WA

VICINITY MAP

Project No. 19-150	Figure No. 1



LEGEND:

- Subject Site
- Existing Structures
- Proposed Addition
- Approximate Boring Location, PanGEO, Inc., May 2019 *(Approximate Depth to Bearing Soil in Feet)*

Note: Modified from Site Plan prepared by AOME Architects, dated December 17, 2018.

PanGEO INCORPORATED	Proposed Addition 8452 North Mercer Way Mercer Island, WA	SITE AND EXPLORATION PLAN Project No. 19-150	Figure No. 2

19-150_Fig 2 Site & Exploration Plan.grf 6/4/19 SMH

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

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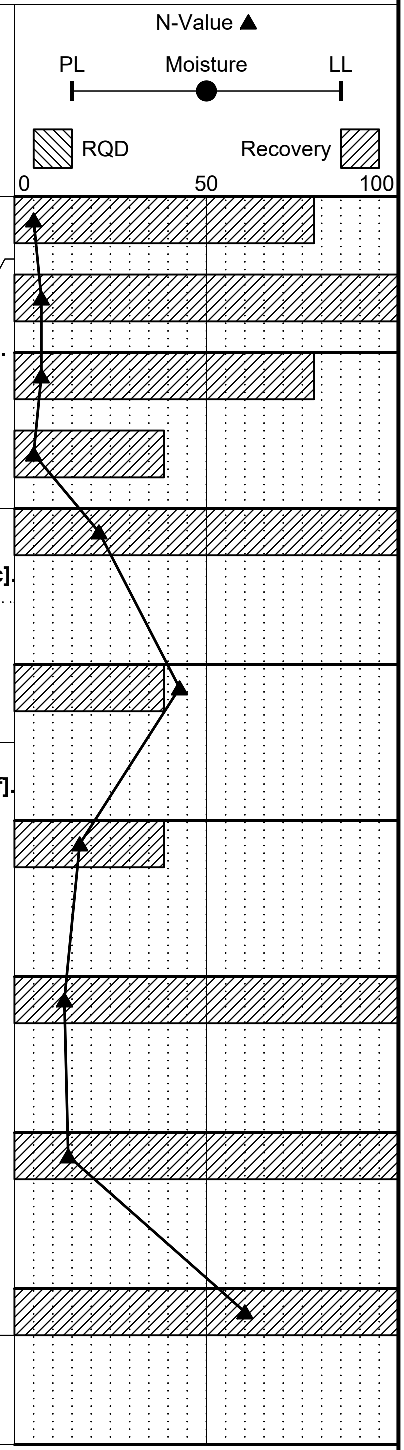
Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	8452 North Mercer Way - Proposed Addition	Surface Elevation:	~37 feet
Job Number:	19-150	Top of Casing Elev.:	NA
Location:	8452 North Mercer Way, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: 47.58519, Easting: -122.2234	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0	S-1	SPT	3, 3, 2			Loose, brown to dark brown, silty, fine SAND, some gravel, organics, fine rootlets; moist. **[Fill].**
	S-2	SPT	2, 3, 4			Loose, brown to gray-brown, silty, fine SAND; moist, occasional iron staining, slightly laminated. **[Mass-Wastage Deposits - Qmw].**
5	S-3	SPT	4, 3, 4			-- Increasing moisture content, occasional fine gravel lenses at about 5 feet.
	S-4	SPT	1, 2, 3			-- Dark brown organic layer at about 8.5 feet below grade.
10	S-5	SPT	7, 6, 16			Medium dense to dense, blue-gray, silty, gravelly SAND; wet to saturated, laminated. **[Pre-Olympia Coarse-Grained Nonglacial Deposits - Qponc].**
						Dense, blue-gray, silty, sandy GRAVEL; wet to saturated, well-graded.
15	S-6	SPT	15, 22, 21			
						Very stiff, blue-gray, silty CLAY, trace fine sand; moist, low plasticity. **[Pre-Olympia Fine-Grained Nonglacial Deposits - Qponf].**
20	S-7	SPT	4, 8, 9			
25	S-8	SPT	4, 5, 8			-- Becomes stiff, slightly laminated.
30	S-9	SPT	3, 5, 9			-- Occasional fine sandy lenses.
35	S-10	SPT	14, 28, 32			--Becomes hard, trace gravel.
						Boring terminated at about 36.5 feet below grade. Groundwater was encountered at about 10 feet below grade at time of drilling.
40						



Completion Depth:	36.5ft
Date Borehole Started:	5/13/19
Date Borehole Completed:	5/13/19
Logged By:	S. Harrington
Drilling Company:	Geologic Drill Partners

Remarks: Boring drilled using a Bobcat-mounted mini track drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb. safety hammer. Hammer operated with a rope and cathead mechanism. Surface elevation estimated from topographic survey by Terrane, dated 8/14/2018.

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LOG OF TEST BORING PG-1

Figure A-2

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